SHOUT
SHARE
IT

Class 639.73

Number N53

Volume 1 cop. 2

Source

Received

Cost

Accession No. 14101

639.73 ~~A 16 Ba~~

Bulletin 46 August, 1897

NEW HAMPSHIRE COLLEGE
AGRICULTURAL EXPERIMENT STATION

1. AN EXPERIMENT WITH A STEAM DRILL
2. METHODS OF ROAD MAINTENANCE

BY CHARLES H. PETTEE

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM, N. H.

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

DURHAM, N. H.

BOARD OF CONTROL

HON. GEO. A. WASON, *Chairman*, New Boston.
PRES. CHAS. S. MURKLAND, *ex officio*, Durham.
CHARLES W. STONE, A. M., *Secretary*, Andover.
HON. JOHN G. TALLANT, Pembroke.
HON. FRANK JONES, Portsmouth.

THE STATION COUNCIL

PRES. CHAS. S. MURKLAND, A. M., Ph. D., *Acting Director.*
FRED W. MORSE, B. S., *Vice-Director and Chemist.*
CHAS. H. PETTEE, A. M., C. E., *Meteorologist.*
HERBERT H. LAMSON, M. D., *Bacteriologist.*
CLARENCE M. WEED, D. Sc., *Entomologist.*
FRANK WM. RANE, B. AGR., M. S., *Agriculturist and Horticulturist.*

ASSISTANTS

LEIGH HUNT, B. S., *Assistant Horticulturist.*
CHARLES D. HOWARD, B. S., *Assistant Chemist.*
CLEMENT S. MORRIS, *Clerk.*
E. H. FORRISTALL, *Farm Foreman.*

The Bulletins of this Station are sent free to any resident of New Hampshire upon application.

AN EXPERIMENT WITH A STEAM DRILL

BY CHARLES H. PETTEE

OBJECT OF EXPERIMENT

The experiment herewith described has been carried out with certain definite ends in view, and incidentally the location has been so chosen as to partially carry out a far-reaching improvement that is at present beyond the means of the town, and yet is absolutely essential to properly set off the approaches to the college. The definite ends were as follows:

1st. To use a steam drill on a sufficiently large scale to determine how far its well-known advantages may be applicable to country road work.

2d. To study the question of comparative cost of moving road material, differing in kind and having a variable length of haul.

3d. To incidentally make a further study of the question of what a standard grade should be.

4th. To experiment with different available materials for surfacing.

DESCRIPTION OF LOCATION AND OF WORK DONE

The locality selected for experiment lies upon the main thoroughfare through the village of Durham, with the property of the New Hampshire College upon either side. This thoroughfare, for over a mile, is bordered upon one or both sides for nearly the whole distance by land of this institution. The street itself as laid out is 66 feet in width, and is nearly straight, but the traveled portion varies considerably from a straight line. Here and there masses of rock encroach upon this traveled way and force it to one side. In other places, deep

ravines, requiring heavy fills, have been equally potent in pushing the roadway from the centre, and both together have caused the sidewalk to curve out toward the centre of the road until that thoroughfare has been encroached upon seriously in places.

Commanding the approach to the main college buildings from the village side, was a hill 510 feet in length, having a continuous grade the whole distance, except for 50 feet near the top, which was level. While the grade was continuous, it varied from one in eight for a distance of 55 feet to one in thirty for a distance of 120 feet, and these grades were so situated as to give a sharp rise for 90 feet in length near the bottom; then an easy grade for 175 feet; then a very steep ascent for 55 feet, with an easy slope beyond. These grades may be seen as represented by the broken lines in plate 1, figure 1, in which the vertical scale is exaggerated five times over the horizontal. The whole line in the same figure shows the grade of the road since its improvement. The lower part of the hill has been reduced to a uniform grade of one in twenty, while the upper portion has a grade of one in twenty-two. In plate 1, figure 2, the straight or nearly straight dotted lines show the former course of the traveled way and sidewalk; the broken lines show the present position of sidewalk, and the whole lines give the bounds of the street as laid out and the bounds of the traveled way as now built. The dotted curved lines indicate the former position of rock areas now removed by blasting. The frontispiece and plates 2–6 give views taken before, during, and since the reconstruction of the road. The traveled way has been graded 22 feet in width, with dirt slopes of one to one at the sides. The sidewalk upon the north side has been rebuilt in its proper place upon the outer edge of the laid-out way, for which purpose a large amount of rock excavation and fill were necessary. Ultimately, as the land on the south is improved, the grade of the road should be carried to the full width of 66 feet. In the part experimented upon, which includes about three fourths of the grading required for its full renovation, care has been taken to do no work which will have to be undone, but the remainder may be carried forward at any time with no interruption to travel. Enough has been done to

PLATE I.

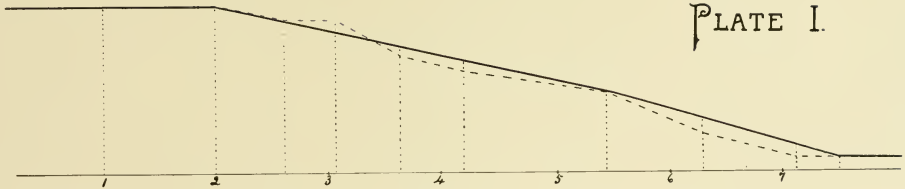

FIG. 1.
(ELEVATION.)

HORIZONTAL SCALE, 100'=1". VERTICAL SCALE, 20'=1".

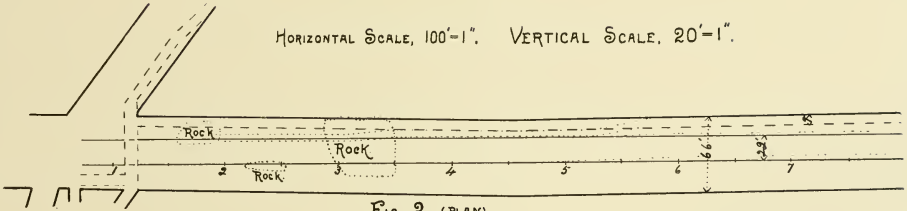

FIG. 2. (PLAN)

prepare this portion of the road for macadamizing, an improvement which it is hoped the town may be able to undertake at no distant day.

RESULTS IN DETAIL

The following table gives in detail the actual results accomplished, together with the cost of each part of the work. The expenses include what were actually incurred and what would have been incurred if the town had been doing the work without aid from the college.

GRADING.

No. cubic yds.	Material.	Aver'ge length of haul.	Source.	Basis of estimate.	Average cost per cubic yard hauling.	Total cost.
554	Clay.	⅜ mile.	College barn.	Count of loads.	27½ cts.	$152.35
146	Hard pan.	5-16 mile.	Rear of Science buildi'g.	Count of loads,	27½ cts.	40.15
24	Hard pan.	½ mile.	Hoitt bank.	Count of loads.	27½ cts.	6.60
50	Hard pan.	200 feet.	Stripping.	Measurements.	27½ cts.	13.75
22	Hard pan.	100 feet.	Ditch.	Measurements.	15 cts.	3.30
15	Cinders.	5-16 mile.	Power station.	Count of loads.	22½ cts.	3.32
16	Gravel.	2½ miles.	Lee gravel bank.	Count of loads.	65½ cts.	10.50
130	Stone.	250 feet.	Stone wall.	Measurement in embankment.	45½ cts.	59.18
258	Stone.	125 feet.	Blasted from ledge.	Measurement in ledge.	111 cts.	286.38

Spreading earth and shaping road-bed	$28.04
Supervision, 36 days at $2.00	72.00
520 loads of earth at 10 cents	52.00
Two culverts—64 feet of pipe, $9.60; labor, $7.72	17.32
Total value of work done	$744.89
Acutal outlay to college	$500.00

If of total cost we rebate amounts for supervision, value of earth furnished, amounts charged for use of drill and machinery, and excess of value of farm teams above $3.00 per day (college experiments are usually carried on upon a basis of expense of $3.00 per day per team, while in table this has been charged

at $3.50 per day), and if we allow something for the value of the stone reserved by the college, the actual net outlay will remain nearly $500, as given above.

Of the total fill, one third was for sidewalk, two thirds for roadway. Of the rock excavation, two thirds was for sidewalk, and one third for roadway. On the whole, 56 per cent. of cost was for roadway, and 44 per cent. for sidewalk.

The cost of moving clay, hard pan, and strippings varied from 25 to 40 cents per yard, differing mainly with the kind of labor employed in shoveling.

RÉSUMÉ

827 yards earth, estimated to shrink in place 1-10 to	744 yards.
258 yards stone, less 20 yards drawn to college barn, equals 238 yards, estimated to increase in place 1-6, to	275 yards.
Wall stone in place	130 yards.
Fills according to above estimates	1,149 yards.
Fills from rough, direct measurements	1,120 yards.
Average	1,135 yards.
1,135 yards at 64 cents (average price)	$727.57
$727.57 plus $17.32 (expense of culverts)	$744.89

THE STEAM DRILL

Steam drills are in common use in cities for grading and sewer excavation, quarrying stone for crushing, etc. They have not hitherto been considered as necessary or even desirable machines for smaller towns. With reference to them, the object of this experiment was (1) to determine whether they are adapted to work carried on by more or less inexperienced hands; (2) to see if the use of the drill as a portable machine for small amounts of work in a place is practically feasible.

While the work done was all within a limited area of a few hundred square feet, the arrangements were on a portable basis, and as a matter of fact, the whole apparatus was moved several times so satisfactorily as to amply justify more frequent

changes and removals to longer distances when necessary. Therefore, a detailed history of the experiment will apply as evidence to both of the above questions.

After consultation with various parties using drills, the writer, having had no practical experience with them, decided to place himself in the hands of some reputable party, handling a reliable article, and follow his advice. Such a party was found in the person of M. S. Harlow, M. E., New England agent for the Ingersoll-Sergeant Drill Co., with headquarters in Boston. After learning the nature of the experiment to be tried, Mr. Harlow loaned the college an Ingersoll B. drill that had been used a few times and yet was practically as good as new, so that the results obtained by its use were perfectly satisfactory. A man was sent from Boston to run the drill for such time as was necessary to teach those on the ground how to handle it, the college paying for this expense. With the exception of the loan of the drill, any other party would have been treated in the same manner by the drill company, and any machine sold would have been fully warranted.

EQUIPMENT

The following list of articles was found necessary for full equipment:

1 Ingersoll B. drill and tripod	$220.00
25 feet steam hose	15.00
1 set special blacksmith tools	8.00
Duplicate set octagon drill steel	16.00
Battery, leading wires, etc.	25.00
Extra fittings, bushings, sand pump, etc.	3.00
Portable 9-horse power boiler, with fittings complete	210.00
50 feet of 1-inch pipe in variable lengths with fittings	5.00
1 large and 1 medium Stillson wrench and 1 large monkey wrench	5.00
2 water barrels, pails, etc.	1.00
1 portable forge and anvil	24.00
Total cost	$532.00

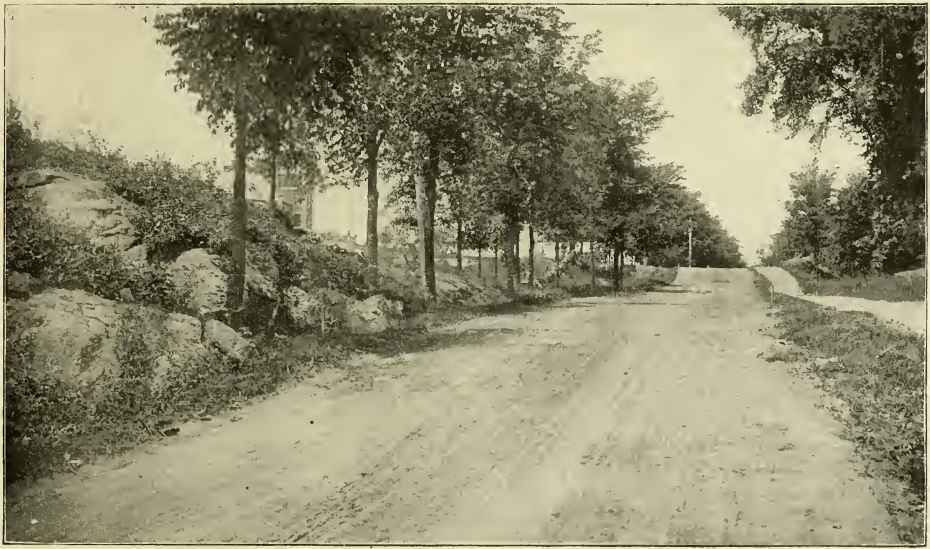

PLATE 2.—ROAD BEFORE RECONSTRUCTION. *(From Photograph.)*

The prices given above are about those that will be accorded to any careful buyer. It will rarely be necessary for a town at the start to secure the boiler or the forge. In almost any town may be found small stationary boilers that may be hired at certain seasons and made portable by mounting upon any low truck. By putting a few dollars extra into steel, the blacksmith work may be economically done at any shop in town, a part of the drills being used while others are carried to the shop. The special blacksmith tools, however, will still be necessary. Under these circumstances, the necessary expense of outfit may be reduced to about $300.

The following force will be required to run the machine: one man for the drill; one man at the boiler; one blacksmith, or one boy to carry drills to shop; and one laborer working near to be called upon as needed. If either the man at the drill or at the boiler be a blacksmith, the drill may be run till all the steel is dull. Then shut down and sharpen up.

In the work now being described, the person who was to learn the use of the drill acted as assistant, and gradually was allowed to assume control of the machine.

In most cases, more or less stripping of earth from the rock is necessary. This should be thoroughly done well ahead of the drill, which may then be placed in the most advantageous positions.

WORK DONE

Seventy-four holes, averaging 3 feet, 3 inches, in depth, or 238 feet in all, were drilled in 67 hours, or at the rate of 3½ feet per hour. This time included one breakdown, using up 3 hours, and various delays due to seamy rock, stopping to instruct blacksmith, moving boiler, lack of steam, etc., but did not include 7 hours spent in blasting, 10 hours setting up and taking down twice each, and 1½ days, time of operator coming, going, and waiting for drill, all of which are included in the tabular expense account heretofore given. The rock drilled was syenite, exceedingly hard, quite seamy, and consequently slow drilling.

In comparison with hand work, not only is the amount done per dollar of expense more, but a class of work may be

attempted that hand work cannot touch, because of the depth to which the holes may be driven by steam power.

The total cost of handling rock, including the work with the drill, was very moderate, being at $1.11 per cubic yard less than the average contract price, which is usually about $1.75 per yard. With the experience gained, the work could be duplicated at a considerable saving of expense. Upon one job, carried on since with our own help, an average of 4 feet per hour was attained, with a labor account per day less than half that in the former case. One run of 8 hours gave 42 feet with 14 holes. These are not record-breaking results, but what has been actually done in very hard rock by amateurs.

NEED OF ROCK EXCAVATION ON COUNTRY ROADS

In order to investigate the question of the need of rock excavation on our country roads various computations were made, and a section of road 5½ miles long was carefully examined to find what amount of rock work was required.

1. Since it is evident from the table, page 62, that yard for yard rock excavation is much more expensive than earth fill, great care should be exercised not to handle rock when earth can be easily drawn to cover the same. In the experiment already related, if the grade had been carried two feet higher, thus avoiding all rock excavation except for sidewalk, the following computation would hold:

Extra embankment, 1,100 yds. earth, at 27½ cts. .	$300.00
Extra embankment for sidewalk, 51 yds. earth, at 27½ cts.	14.00
Total increase in expense	$314.00
Stone, replaced by earth at saving of 83⅓ cts. per yd., 181 yds., ...	151.00
Net saving by larger use of steam drill . . .	$163 00

If a grade one foot higher than that adopted had been used, practically the same rock surface would have been covered and the total expense have been still greater. Therefore, as a mere matter of expense, a standard grade was attained in the best way.

PLATE 3.—AFTER BLASTING. *(From Photograph.)*

2. The examination of the 5½ miles of road referred to above showed at least fifty places where rock excavation is necessary, either to open up the side ditches so as to keep the water out of the traveled way or for the improvement of grade. No account was taken of the numerous cases where earth could be more cheaply drawn and thus save ledge excavation. This highway is about an average of the better class of country roads in the hill towns of New Hampshire.

RÉSUMÉ

As a result of both experiment and investigation it would then seem legitimate to draw the following conclusions:

1. There is need of a large amount of rock-work upon the average country road.

2. The steam drill is absolutely essential for the economical handling of considerable rock masses, and is capable of doing exceedingly economical work, in portable form, for small amounts of work in a place.

3. The ownership of the necessary plant, especially with boiler and forge omitted, is within the means of a large number of towns.

4. A good opportunity for starting such an innovation as above outlined may be found frequently in connection with the carrying out of some single large improvement involving rock excavation. In such case the total expense of plant may be saved the first season.

5. The obvious objections are connected with the lack of permanent organization of the department of roads and the frequent changes of management in our country towns. This is illustrated by the fact that probably two thirds of all the road machines in the state winter in the open air.

6. On the other hand, a steam drill is not bulky and would be left usually in the care of the person who had learned to run it. In that case it would receive all necessary attention.

7. A steam drill is simple in construction; is made to stand banging, and is less liable to get out of order than many articles of modern farm machinery in common use.

COMPARATIVE COST OF MOVING ROAD MATERIAL.

Different materials moved were as follows: Rock thrown out by blasting, rock from an old wall, clay from barn cellar, hard-pan full of bowlders and small stones, a small amount of cinders and gravel easily handled. For details of number of yards, length of haul, cost, etc., see table, page 62.

The cost of moving ledge rock is altogether too great to allow its profitable use in ordinary embankment. When, however, the rock must be moved, it can often be used to advantage in grading. Deep drilled holes, a good quantity of at least 75 per cent. dynamite, and a battery for use in exploding were found necessary for the satisfactory breaking up of masses of rock, while a hand derrick, which may be hired for about one dollar per day, was found to give far more economical results in handling rock than could be attained without. Without going into details, all these points are of special importance and can hardly be emphasized too strongly when rock-work is under consideration.

We see by examination of table that the economic value of an old wall for grade at a distance above fifty feet is exceedingly problematic. The size of the stone will be the determining factor. In the case under consideration, about two thirds of the stone had to be handled with bars and many stones were loaded upon the drag by aid of horses. When we consider further the additional expense required in packing the rocks together to make a fairly compact fill, it may be regarded as settled that it would be cheaper to draw earth at least one half mile than to utilize a wall of large stone over fifty feet distant.

The cost of handling earth varied from 15 to 66 cents per yard, the variation being largely due to the difference in the efficiency of the shovelers and not appreciably to differences in length of haul as great as one fourth mile. The highest cost, except for gravel, viz., 40 cents, was for earth moved only a little more than one fourth mile. Again, it can not be too strongly emphasized that the selection of the right number of shovelers and the right number of teams, proportioned to the distance to be covered and the kind of material to be moved, is a vital factor. I have in mind one third section of a town

PLATE 4.—LOWER SECTION OF ROAD PARTIALLY FILLED. *(From Photograph.)*

where most of the road work for several years has been done by a single team, sometimes with and sometimes without an extra shoveler. It would be hard to say which combination was worse for the town. While this is an extreme case, individual instances of such wasteful work are of daily occurence. Perhaps equally important is the size of the load drawn. It was found that an average team ought to draw on a main road, not too hilly and free from mud, at least forty feet or thirty-two bushels of earth. Yet twenty bushels or less than a yard is nearer the average load hauled by teams working for our towns.

Failure to attend to these details frequently triples the necessary expense. In this experiment, the cost of hauling earth and rock was less than the average cost to contractors and considerably less than the average cost to towns for road work. The clay moved from under the college barn had dried and hardened into an exceedingly compact mass, every inch of which had to be picked or otherwise broken up. Dynamite was tried several times quite successfully, but on the whole muscle and picks proved cheaper. With less effective muscle, however, the result might have been reversed.

A STANDARD GRADE

In reducing the grade of a hill to a standard of one twentieth or a little less, it was not expected that much additional light would be thrown upon the question of what a standard grade should be. It was a single example, and whether the college or the people of Durham thought this particular grade the most profitable or at all better than the old, is of little moment to outsiders. Towns, however, will go on cutting down their grades to about the proportions that the experience of Europe and of the more thickly settled portions of this country advises as fast as they get round to the point of making good roads, and this experience has been followed in the case under consideration.

It may be profitable, however, to notice some of the arguments employed by a few individuals to show that the new grade was no improvement over the old. It will be seen by Plate I, that formerly the grade was concentrated largely at two points, and it has been argued that this concentration

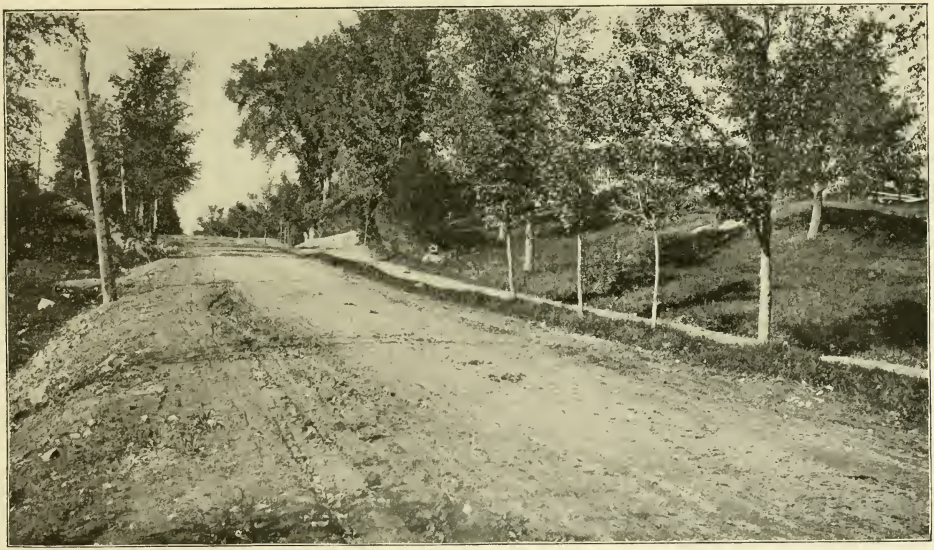

PLATE 5.—ROAD AFTER RECONSTRUCTION. *(From Photograph.)*

enabled a team to get over the elevation more quickly and easily than now with a longer hill having a uniform grade. In this case, there was no increase in the total length of road, rather a slight decrease, but only an increase in the length of the hill. There can be no question that, with the same road surface in two cases, a heavy load would steer clear of a grade of one eighth every time, and also of a grade of one twelfth for as great a distance as ninety feet, in favor of a uniform standard grade of one twentieth. Moreover, since it is found that a driving horse with a light load will trot steadily along on a standard grade and that a heavy load may be easily started upon such a grade, it remains at least doubtful whether the extra speed claimed even in the case of a medium-sized load on the concentrated grades is not taken out of the animal driven.

In riding a bicycle, it is noticeable that an ordinary rider may climb a hill at a standard grade without marked increase of effort, and with regular, steady motion, while upon a steeper hill, even if quite short, a special effort is necessary to get up sufficient momentum to carry one up the steep part, and this effort leaves one out of breath at the top, or, perhaps, only half way to the top. We think it is the same with the horse on the steep grades, and that the extra effort required to climb a hill quickly comes out of the reserve strength of the animal, and, therefore, is no real gain. It may be easier in some cases for the driver to concentrate his efforts at a few points while urging on the average horse but the owner of the animal would prefer the standard grade.

One fact was clearly shown as a result of the experiment, viz., that a hard surface may counterbalance a steep grade. After the completion of the grading a portion only of the hill was graveled, and that lightly. As a result the road was unusually muddy the following spring, and there is no doubt but that the harder surface with the steeper grade would have been preferable for the time. As the question of surfacing, at least as well as before work began, involves simply the expenditure of a few dollars for gravel, there is no argument there against reducing grade. It is important, however, as teaching the great utility, yes, even absolute necessity, of surfacing in order to procure good roads.

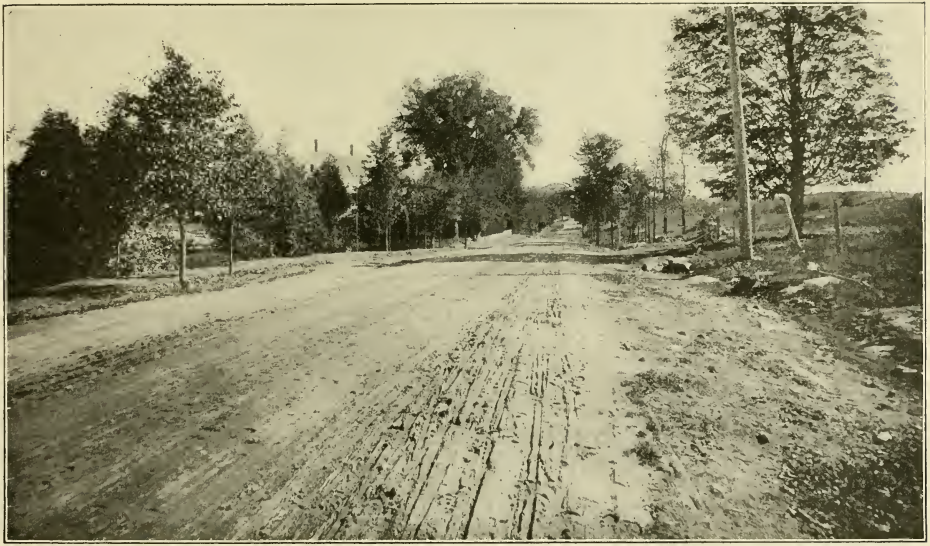

PLATE 6.—VIEW FROM TOP OF HILL AFTER RECONSTRUCTION. *(From Photograph.)*

ROAD SURFACING.

It was intended to carry out a series of experiments with different materials in surfacing, but so much effort was found necessary to complete the grading that only a small amount of work was done in this line. The main experiments were postponed, and mean-time a careful study of surfacing methods was entered upon in connection with the study of town management of roads, as specially exemplified in the town of Durham. Therefore, the little that was done will be considered in connection with the latter subject.

A PRACTICAL STUDY OF ROAD MAINTENANCE

BY CHARLES H. PETTEE

PRELIMINARY REMARKS

Conclusions drawn from actual practical work, when the surrounding conditions are carefully studied, are frequently very instructive. With this thought in mind, and with a purpose to accomplish as much as possible with the available college resources, the highway agents of the town of Durham were consulted, and, with their willing coöperation, the task was entered upon of studying for a year the work done by them, and of making report thereof, so far as lessons of public interest would warrant.

Infallibility in criticism is not claimed, and the writer is glad at the outset to testify to the honesty, ability, and general business acumen shown by all the members of the board of highway agents, and to the gentlemanly treatment accorded to himself and others with whom they came into business relations.

All personal criticisms* made, whether favorable or otherwise, are such as might easily apply to a large number of highway agents throughout the state, and refer to matters that generally need attention and correction.

ORGANIZATION FOR 1896–'97

At the town election in March, 1896, three highway agents were chosen, whom we will speak of as A, B, and C. A was reëlected and thus brought to the service of the town an experi-

*All personal criticisms made have been submitted to the individuals concerned, and are published with their consent.

ence and knowledge of previous work which was very valuable, and which tended to strengthen the growing conviction that highway agents should have a longer tenure of office than one year.

B also had had practical experience in working on roads and knew thereby how a well-surfaced road should be made. A and B worked together through the year without any division of territory or money.

C took about one third of the town for his territory, a certain portion of the total appropriation being set apart by agreement for his use. By this division an interesting illustration of both single and double management of roads was presented. As each proved successful in its way, it would seem to be pertinent to call attention here to the elasticity of our present law, by virtue of which it adapts itself to all sorts of conditions and personalities.

CRITICISMS

B knew how to make a good road surface. Conditions favored him in the early spring and he drew considerable quantities of gravel economically after the snow left and before the frost came out of the ground. This was spread where needed and worked into the mud as the frost came out, leaving as a result a remarkably hard and smooth surface. The best example of this work may be seen upon a hill on our main thoroughfare. The agent for the previous year had made an excellent and much needed beginning by drawing clay to reshape the road which here was practically washed out. The gravel which B put on in the spring was incorporated with the clay, making an extremely hard and durable surface, which was smooth through the summer, came out dry and hard in a remarkably muddy spring which followed, and has withstood the wash of heavy rains in an exceptionally wet season since. It is possible that some such combination of clay and good gravel will furnish the coming road for many sections of our state. It appears especially adapted to withstand washing on our hills, and when thoroughly underdrained remains dry and hard in the spring. The incorporation of clay and gravel in the spring seems to be unusually thorough and there-

fore desirable. The same result may frequently be accomplished at less cost by drawing gravel late in the fall, or by sled in the winter. In the latter case a double handling is generally necessary, which is not usually economical.

As a whole, A and B did not pay sufficient and prompt attention to little things. Such gullies as existed for months in numerous places on our main roads should have been filled up within a week of their formation. All catch basins should have been kept clear, and water should not have been allowed to run down the middle of the road on hills, while loose stones should have been picked up. Prompt attention to inexpensive details through the season will make and save more dollars than anything else. People enjoy riding over a smooth road. For best method of securing this attention to details, see "Highway laws," page 85.

If any great mistake was made in C's district it was the very natural and exceedingly common one of expecting to do more than could possibly be done with the money at hand, and consequently finding that the money would not hold out to go round. This error is quite excusable in the case of a zealous worker who takes up the business for the first time, as was the case here. It resulted, however, in an undue expenditure of money upon the roads first repaired, while others which in some respects needed it most had to suffer. It should be stated, however, that the main road through one half the district was put in fine condition and kept so through the season.

Another criticism, applicable, however, to the work of all three agents, was the method of use of the road machine in many places. Doing too much for mere smoothing and too little for the repairs really needed, it frequently created a nuisance by stirring up the traveled way and leaving it rough with sods, stone, etc. For details of what ought to have been done see "Road machines," page 81.

During the year considerable permanent work was accomplished, such as relaying the abutment of a bridge, rebuilding numerous large and small culverts, and improving the grade in several places, thus setting an excellent example for other towns to follow. In an average year with a fair appropriation, some permanent work always ought to be done. On the whole,

the roads of the town were distinctly improved as the result of the year's work.

C kept his accounts in a model manner. A pocket note-book showed at a glance, at any time, just what work had been done, with all amounts due on the same. It would be well if there were more such clear accounts of our public business in existence.

A and B kept their accounts well in hand, and knew—largely by memory—about what their outstanding bills were from time to time. They had, however, the usual horror of all book accounts outside of a single cash statement stating what had been paid out. Where business has to be done upon a credit basis, as is the case usually in road construction for at least six months of the year, attention to outstanding accounts is imperative. It should be the business of some one to keep a record of all work done and every article bought, and report the same to headquarters systematically, not depending upon bills brought in after months have elapsed since service was rendered.

As a result of the special study of the roads of Durham, and of other roads for many years, the writer desires to add a few thoughts on each of several subjects.

ROAD SURFACING

Proximity to almost any kind of a gravel bank seems to be the most frequent controling element in deciding what material shall be used for surfacing. This gravel may be good, bad, or indifferent for its purpose, and the road follows suit, but the gravel is used all the same. While it is true that very excellent results may be attained by a proper admixture of even pure sand with a heavy clay soil, it does not follow that the sand alone would make a good surfacing material. I find a quite general disposition to use a gravel with too much sand in its composition. With heavy soils, at certain seasons, it produces fair results, but usually before it can become properly incorporated it is washed to the bottom of the hill or into the side ditches. Surfacing material is too costly to throw away in this manner. In all cases, the coarser material is more

durable and makes a harder surface, and at anywhere near the same cost should be preferred. Many times I have seen teamsters pass over the coarser gravel in a gravel bank because the finer shoveled easier. The incorporation of somewhat uniform stony gravel with clay on a well-drained foundation gives a surface in some respects superior to macadam.

ROAD MACHINES

Road machines are adapted to the work of the quick and economical removal of earth from the sides to the middle of roads, and they are excellent for smoothing up a rutted road, provided the blade of the machine is inclined backward instead of forward, as in common use. I will only speak of the former use. If it is necessary to remove earth to the centre from the sides, the road machine may be profitably used, but it is not always desirable to do this to a road. A road surface should be hard, smooth, and properly shaped. Months of travel are frequently necessary to consolidate the material on a road surface. This should not be ruthlessly torn up or covered with sods and sand each year, for the sake of making people think that something is being done. In ordinary cases, outside of villages, we cannot obtain grade in any way so cheaply or well as by the employment of a road machine, but when a piece of road is once taken in hand, a thorough job should be done.

The road should be properly shaped clear to the side ditches, and then covered with sufficient good gravel to smooth over and bind together the sods, sand, stones, etc., brought in from the ditches. In any country town raising on the average $25 or more per mile, I would not use a road machine upon a main thoroughfare without following with the cart to cover sods, stones, etc., with good surfacing material. If I could not do a whole road one year, I would do the worst places first, especially the hills, rounding them up and obtaining as hard a surface as possible. I would leave the completion of the work for the following year. Thereafter, with the occasional exception of repairing damages by freshets, etc., I would keep the road machine largely at home, doing enough each year, and each season of the year, with the cart, or simply with the

shovel, to hold the road where it has been placed. On level or nearly level ground, this work will be found very slight, provided only a good surfacing material is available and the traffic is not of the largest amount or heaviest kind. The constant passage of stone and other heavy teams is very trying even to a good road.

Hills, particularly steep ones, require constant attention and expenditure; hence a strong argument in favor of permanently cutting down grades.

The shape of the road-bed is important. Usually one of two extremes in using the road machine is met with. Either the operator is afraid of cutting down the hips of a road, and so leaves a ditch on each side inside the main ditch, which very commonly results disastrously, especially on hills; or else the hips are cut entirely down, leaving a steep, rounded shoulder which narrows up the way, exposes the surface to unnecessary wash, is frequently positively dangerous for passing teams, and allows the road, in homely phrase, to squat out at the sides. The surface should be a straight line from the centre to the side ditches, with a suitable grade to each side adapted to the longitudinal grade of the road, being more crowning as the hill is steeper. If the hips are in the way, cut them down just enough for the grade and no more. Be sure to carry the grade straight from centre to inner edge of ditch; frequently to bottom of ditch when elevation of road-bed or drainage does not require an extra depth to these appendages.

HIGHWAY LAWS—THE OLD AND THE NEW

During the recent session of the legislature of New Hampshire, an effort was made to return to the old district system of highway management. This attempt failed, but was supported by many of the rural communities because of dissatisfaction with the working of certain features of the new law. As both the old and the new laws are very generally understood, it will not be necessary to quote them entire in commenting upon certain portions of them here.

There were two features of the old law, so frequently vicious in their practical working, that it is doubtful if it were wise for any town to readopt them. One of these, viz.: the clause

allowing taxes to be worked out in labor, has been frequently discussed, and that with varying expressions of opinion.

The other, which made the district the unit for raising highway money, and in general for expending it, was, at times even more vicious in practice, and, what is more, its evil was not generally recognized. Let us examine the practical working of these two features of the old law. Under the first, the district highway surveyor was at the mercy of his employés, who many times would work only when it was convenient, and as they chose, frequently not working at all. Shrewd men, not desiring to work out their own taxes, sold the privilege to their neighbors for so much on the dollar. If coaxing failed to secure the tax in some form, other means, though lawful, were rarely resorted to. In short, the tendency of this part of the law was evil, and if it had not been for another excellent and restraining feature, would long ago have proved unbearable. Again, the district was the unit, and, as a rule, taxes were assigned to the districts where they were assessed. A special effort had to be made, and therefore was rarely made, to take money from one district into another. If important roads in some poor district were going to pieces the selectmen would allow the surveyor money raised for general town purposes to help him out rather than offend other districts by withdrawing what they were accustomed to look upon as their own. Quite a number of back country towns, with large road mileage, find it a serious burden to raise $15 per mile of road per year; $25 to $30 is perhaps a fair average of our country towns. A few come up to the limit allowed by law of $50 per mile. Our cities, acting under charters, may expend several hundred dollars per mile of road and still not be taxed at nearly as high a rate as the small town which raises the $15. While the expense per mile for construction and maintenance increases rapidly with the larger traffic of the village or city street, this increase is nowhere near in proportion to that in resources. There is no difficulty whatever in convincing any fair-minded person that money ought to be taken from these large centres and expended upon the roads in the country towns, and the demand for this is just. It is one of the fundamental arguments in favor of

some state system of highway construction. Frequently, however, when we ask the individual, who formerly lived in a favored highway district, with taxes in many cases not more than half worked out, to apply the same principle to his own town, he does not look at it in the same light, but will be found calling for a return to the old law. I have talked with numerous men, most of whom were well-informed and intended to be fair-minded and just, who have complained bitterly because the new road law took away so much of their highway tax. On further inquiry, I have found in several instances that such parties had been living in some of these favored districts that had been kept up at the expense of other portions of their towns. It will take a generation to fully outgrow the effects of this system, and meantime every reasonable effort should be made to clearly set forth the unfairness of any law which practically would require the expenditure of highway taxes in the districts in which they are assessed.

Let us turn now and look for some of the better features of the old law. I do not hesitate to say that the best feature—that which mitigated, and perhaps in many instances entirely suppressed, the general tendency to evil, was that which gave us the district unit for the expenditure of highway money. Let it be clearly understood that I do not mean the district system for raising money. The town itself is too small a unit for this purpose, but it is the best we can obtain at present. The old law went too far in expending all the money by the district plan, but experience has proved that the people desire to have some one in each neighborhood who has authority and a reasonable amount of money for making all the ordinary small repairs as they are needed throughout the season.

Let us consider for a few moments what an ideal system of road maintenance within a town would be. Without doubt, it would consist in the selection, possibly by the board of selectmen, of a practical road builder, who should devote his entire time to a study of the needs of the town and to the superintendence of all the work done. This is the method adopted in the city and in a few of the largest towns. It is not applicable to the country. In many, many towns the total money raised for roads would not pay the salary of a man who was skilled in

road construction and maintenance. The ideal system, then, is out of the question. Evidently, therefore, we should seek the aid of that man in town who best understands the problems involved; who is practical in carrying out his ideas, and who is willing to devote some of his time to the public without expecting to make a business for himself out of it.

How best can such a man be found? Some say by appointment of selectmen; others by election. I will not pretend to answer this question. In the long run, I would quite as soon trust the people as the wisdom of a board, though not always by any means. In any case, after appointment, he should have the selection of sub-agents; should have the power to remove them for cause, and preferably, should be allowed to arrange the several districts under the limitations of the law which should require the appointment of such sub-agents with jurisdiction covering not more than four miles of road each. Monthly statements by each sub-agent of all work done should be required, payment for same being conditioned upon the presentation of such reports within a specified time. All large repairs, including necessary running of road machine, extensive repairs to bridges and culverts, gravelling sections of road, grading hills, etc., should be done only under direct supervision of road agent or by his special order.

The great advantage claimed for this system is that a partial application of it has worked well in practice. In short, the salvation of the old law was the small district in which the surveyor had a personal interest and pride, and which in many instances impelled him and those working with him to work with extra fidelity, and in many cases extra time to get the roads into suitable condition. Lack of supervision, however, and power to concentrate a portion of the funds in special districts, prevented all extensive improvements under the old law. Under the new, there is nothing to hinder the appointment of sub-agents, but practically this has been largely prevented; (1) by the election of three highway agents in each town. With only one third the money to expend, most agents have been unwilling to divide the money further by sharing with sub-agents this expenditure. (2) Even when one agent has been given a whole town, he has usually felt it his duty to

personally superintend about all the work done. This has frequently caused delay in attending to needed repairs, and often entailed needless expense on account of distance traveled, particularly when so few of those elected road agents have been specially fitted for their work. Under these circumstances, the people have been uneasy and jealous of the absorption of so large a per cent. of the road money by a single individual and frequent changes in the personnel of the office have been the rule.

An amendment to our present law which would limit the number of highway agents to one, and which would compel this one to appoint an average of not less than one sub-agent for each four miles of road, with other limitations already indicated, and with permission to towns to adopt this amendment or not as they chose (it might not be advisable for a few of the larger towns) would do more to popularize the present law than anything else I could suggest, and would restore us in improved form that feature of the old law which in the present state of evolution of road construction and repair, is about the only one worth preserving. The recent amendment placing the highway agents under the selectmen seems liable to be of doubtful utility. While it may in some instances prove a needed restraint, is there not danger of unnecessary friction in placing one set of elective officers absolutely over another with whose appointment or discharge they have nothing to do? The selectmen should by law be compelled to thoroughly audit the accounts, including all outstanding accounts, of road agents at least every three months, and not a dollar should be allowed them above what has been voted. In emergencies arising after road money is expended, necessary repairs should be made directly by the selectmen. The great objection to the present law arises from the concentration of so much power and patronage in so few hands, when those elected have so little fitness for the work, and merely use the office to draw as much money as possible into the pockets of their families and themselves.

No law should define too closely the duties of the sub-agent. He should be under the highway agent and amenable to him. The law should imply a wise, general but inexpensive supervision by the chief. It might be expected to work in practice

something as follows: With an ordinary or even weak man at the head it would amount to a division of the money among districts, with the advantage of a distribution each year according to the needs of the several parts of the town. With a strong man at the helm the work would be systematized and co-ordinated, and real progress would be possible. In any case, as the sub-agents would be appointees of the highway agent, and presumably his friends, they would to some extent assist and restrain, while being in a state of mind open to conviction as to practicability of new methods suggested by their chief. In this way progressive views would make rapid progress, and we should have growing up in each district men who were really competent to manage the roads of a whole town.

A good highway agent should be allowed more than one year of service. In three years he ought to prove what was in him. Under the limitations above suggested it would be reasonably safe to require a two-thirds vote to proceed to the election of a highway agent on each of the two years following the election of such agent. Otherwise he might hold his place unmolested.

Finally, we should strive to perfect the present law rather than work backwards. The strong point in its favor, as it stands, is its elasticity. Under it a town can have the best system if it elects the right man, but this very elasticity has proved a strong temptation to selfish men to use the office for their own advantage, and therefore I feel that some amendment restricting or distributing the power is advisable. Until it is amended we may perhaps wisely use our influence with our agents to experiment in some of the directions I have outlined.

PUBLIC OPINION ON HIGHWAY MAINTENANCE

On the whole, it is my judgment that people in country towns expect too much of highway agents. Unable or unwilling to pay the price of skilled labor, and usually unwilling to allow any one person to remain in office long enough to learn by experience, our citizens often think that if only they could take hold a different showing would be made. When they try it, they find it is not easy to make a great advance with from $15 to $40 per mile of road. I am sure that the number in

any one town, who are competent to expend our road money, is quite limited, though, with all our faults, we make a better showing in economy than the cities. Some who are competent will not bother with the business. With all these drawbacks, it is not strange that numerous false moves are made.

The lack of sub-agents to properly present the needs of each small district, together with the meager records in our town reports of work done, leads many honest citizens living in neglected districts, or in those where the necessary amount of work is small, to conclude that very little work has been done anywhere. As a result, combinations are frequently made to elect men to represent new sections the following year. In this way many come to think that they have been specially elected to put their own districts in order, which they immediately proceed to do, looking after their own personal interests while they have the opportunity. Of course such a spirit is detrimental to the interests of a town. The appointment of sub-agents would remove much of this trouble. Moreover, great gain would result from the concentration of public opinion upon some broad-minded man of good judgment in selecting assistants; having the ability to work through these agents, while holding them to a strict accountability; a person to whom this work would be incidental, and not the main source of livelihood; preferably one who had no team that he desired employed a large portion of the time.

63973 N53 1 copy
New Hampshire
Bulletins 1-48